

On the taxonomic history of *Phyllocnistis* Zeller, 1848 (Gracillariidae)

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Abstract. For over 150 years, the proper taxonomic placement of *Phyllocnistis* Zeller has remained largely uncertain. The genus shares morphological and life history traits with several different families of Microlepidoptera, and these characteristics have made it challenging for microlepidopterists to correctly place the genus. *Phyllocnistis* includes *P. citrella* Stainton, a globally important economic pest of citrus. We review the taxonomic history of *Phyllocnistis* and provide a comprehensive list of references.

Introduction

The leaf-mining genus *Phyllocnistis* Zeller, 1848 is an example of a poorly studied genus whose taxonomic placement has vacillated between many different families. Eighty seven species of *Phyllocnistis* are described worldwide (De Prins & De Prins 2005, 2009), 36 from the Oriental region, 17 from Australasia, 15 from the Palearctic, and 12 each from the Nearctic and Neotropical regions. Only five are known to occur in the Afrotropical region (De Prins & De Prins 2005, 2009). The distribution of most species is restricted to one biogeographical region. However, five species cross biogeographical boundaries: *P. saligna* (Zeller, 1839) occurs in the Palearctic, Afrotropical, and Oriental regions, *P. selenopa* Meyrick, 1915 in the Oriental and Australian regions, *P. toparcha* Meyrick, 1918 in the Palearctic and Oriental regions, and *P. vitegenella* Clemens, 1859 has a Holarctic distribution. *Phyllocnistis citrella* Stainton, 1856 has a cosmopolitan distribution. There are currently more than 800 publications on *Phyllocnistis*, most of which focus on the pest species *Phyllocnistis citrella* (Fig. 1).

Phyllocnistis is very similar to the Lyonetiid genus *Leucoptera* Hübner, 1825 in forewing pattern, but differs in having a smoothly-scaled head. Unlike most genera of Gracillariidae, all larval feeding instars of *Phyllocnistis* are sap feeding, creating a long, slender, serpentine, subepidermal mine, containing a dark median frass line deposited under the leaf epidermis. There are no tissue-feeding instars, hence no granular frass, but only three sap-feeding instars and one non-feeding, highly specialized, spinning instar. The mine terminates in a slightly enlarged cavity, usually near the edge of the leaf in which the last instar constructs a flimsy cocoon and pupates (Emmet 1985; Davis 1987, 1994; Davis & Robinson 1998; Parenti 2000). *Phyllocnistis* is very successful in its ability to exploit a wide range of host plants as it feeds on 26 plant families (Davis 1987; De Prins & De Prins 2009). Some species of *Phyllocnistis* (e.g., *P. citrella*) are cosmopolitan, fast spreading pests, causing substantial economic damage (Davis 1994; Heppner 1995; Heppner & Dixon 1995; Hoy 1996; Causton *et al.* 2006; Jahnke *et al.* 2006, 2007). For the Species of *Phyllocnistis* can often be distinguished



Fig. 1. *Phyllocnistis citrella* Stainton. Italy, Piemonte, Asti, fraz. Valgera, 120 m, 2–15.11.2002, e.l. *Citrus* sp., leg. G. Baldizzone, coll. MHNG. Forewing length ca. 2 mm.

by pupal morphology (Kawahara et al. 2009). The present paper aims to summarize the taxonomic history of *Phyllocnistis*.

Taxonomic history

Zeller (1848) described *Phyllocnistis* as a genus of “leaf-mining moths with eye caps” placing it just after *Lyonetia* Hübner, 1825 (Fig. 2). Soon thereafter, Herrich-Schäffer (1853–1855) placed *Phyllocnistis* in Tineidae, together with many other genera of small Lepidoptera. Stainton, in his lists (1854a–c, 1859), placed *Phyllocnistis* in the family Lyonetidae [sic], and this was followed by Frey (1856) and Wocke (1861, 1871). According to Stainton (1854a) the family Lyonetiidae contained five genera: *Bucculatrix* Zeller, 1839, *Cemiostoma* Zeller, 1848, *Lyonetia* Hübner, 1825, *Opostega* Zeller, 1839, and *Phyllocnistis* Zeller, 1848. However, in his lecture of 7 January 1856 to the Entomological Society of London, Stainton (1856) presented ‘*Phyllocnistis citrella* Atkinson in litt.’ as a new species of Indian Microlepidoptera feeding on *Citrus*. Stainton did not place this global economic pest into any of the then recognized lepidopteran families. He only indicated that the new species was similar to the European *Phyllocnistis saligna* (Zeller, 1839) and *P. suffusella* (Zeller, 1847). Wocke (1861) added *Phyllobrostis* Staudinger, 1859 to the list of Lyonetidae [sic] and later (1871) added *Opogona* Zeller, 1853. At about the same time, Herrich-Schäffer

Paipi penduli filiformes.

Alae anteriores caudatae; cellula discoidalis acuta venulas tres in marginem anticum, unam in apicem, unam in marginem posticum mittit; vena subdorsalis simplex: posteriores lanceolato-lineares, vena mediana dorso proxima venulas tres emittente.

Tibiae posticae supeme setoso ciliae.

Larva apus cuniculos agit in foliis.

Metamorphosis in cuniculo contracto.

Von dem vorigen Genus unterscheidet sich *Phyllocnistis* schon durch die überall schuppenförmige und glatt anliegende Kopfbedeckung und die kürzern, weniger feinen Fühler. Die Vorderflügel haben eine kürzere Spitze und die Hinterflügel sind breiter. Die gleichfalls glatköpfige Gattung *Comiotoma* weicht durch den völligen Mangel der Taster und die ungeschlossene Zelle der Vorderflügel etc. ab; *Opostega* hat sehr grosse Augendeckel und ein nur aus vier einfachen Adern bestehendes Adergestell der Vorderflügel.

Auf den Vorderflügeln ist die Mittelzelle breiter als bei *Lyonezia*, und aus der Spitze derselben gehen nur zwei aus demselben Punkt entspringende Adern in die Flügelspitze. Die Subcostalader sendet zwei Äste in den Vorterrand, deren erster viel kürzer ist als bei *Lyonezia*, die Medianader einen in den Innenrand. Ihr ziemlich nahe ist die Flügelfalte. Die Subdorsalader ist einfach, ziemlich kurz und gebogen. — Die Hinterflügel sind auf der Wurzelhälfte breiter als bei *Lyonezia*, aber am Vorderrande hinter der Borste gleichfalls erweitert. Die wie dort zarte Subcostalader geht bald in den Vorderrand über, um ihn in seinem übrigen Verlaufe zu verdicken. Die Medianader nimmt ihren Lauf nahe am Innenrande und hat erst einen langen Ast (bei dem ich aber ganz sicher bin, dass er die mit ihr verschmolzene Subdorsalader ist) und dann hinterwärts einen viel kürzern.

Die Miniraupe hat keine Beine; sie ist nach ihrer Struktur noch schlecht bekannt. Ihre Verwandlung in-

verdunkelt, hat aber auf den Vorderrandfransen ebenfalls vier braune verloschene Querstriche; die zwei hintersten setzen sich bis auf die Hinterrandfransen fort. Das tief schwarze Pünktchen der Flügelspitze hat auf den Fransen hinter sich einen bräunlichen Querstrich, aus welchem das bräunliche, ziemlich lange Franzensschwänzchen hervorkommt. Die Hinterrandfransen bräunlichgrau. Hinterflügel wie bei *Padifoliella*.

Untersseite etwas glänzend, bräunlichgrau, auf den Vorderflügeln haben die weissen Fransen um die Spitze die Zeichnung der Oberseite.

Das Exemplar in *F. v. Rössl's* Sammlung war aus Böhmen; das vor mir befindliche aus der *Mami'schen* wurde einzeln im Juni 1842 bei Tivoli nächst Wien an Eschen gefangen. Beide Exemplare sind Männchen.

Anmerk. In der Aufzählung der von mir in Italien gesammelten Falter habe ich eine fragliche *Lyonezia somnifoliella* (von Messina und Syracus) beschrieb.

Da ich nur drei Exemplare besitzt, so habe ich noch keine der Untersuchung des Flügelsäckers opfern wollen. — Von *Mama* erhielt ich aus der Wiener Gegend eine *Gracilaria convolvella* n. sp., die bestimmt keine *Gracilaria*, sondern nach genauer Prüfung einerlei mit meiner *Somnifoliella* ist. Von ihr habe ich das Geäder untersucht und mich dadurch von der Richtigkeit meiner Vermuthung, dass es keine *Lyonezia* sei, überzeugt. Die Subdorsalader ist nemlich ganz einfach. Die Discoidalzelle läuft sehr spitz zu; aus der an der Basis sehr verdünnten Subcostalader läuft erst aus der Mitte, dann vor der Spitze ein Ast nach dem Vorderrande; aus der Spitze der Zelle kommt eine Ader, die erst einen Ast an den Vorderrand nicht und sich dann in eine Gabel theilt; die Medianader, innerhalb deren die Falte deutlich ist, sendet vor der Spitze einen einzelnen Ast. Wohin diese Art gehöre, weiss ich noch nicht zu bestimmen.

Phyllocnistis n. gen.

(Fig. 31–33)

Caput convexum, laevigatum.

Antennae conchula parva instructae, alis anterioribus breviores.

(1857) recognized *Phyllocnistina* as a separate group, which included three genera: *Bucculatrix*, *Cemiosoma*, and *Phyllocnistis*. On the basis of wing venation, Clemens (1859) transferred *Phyllocnistis* into *Lithocolletidae*, together with *Leucanthiza* Clemens, 1859, *Lithocolletis* Hübner, 1825, and *Tischeria* Zeller, 1839. Clemens (1859) placed these four genera in *Lithocolletidae*, but noted that his classification was in contrast to European authors who treated *Leucanthiza* and *Tischeria* as *Lyonetidae* [sic]. Unfortunately, Clemens did not indicate who the European authors were. Clemens also stated that he did not support the separation of these four genera into distinct families. At that time *Phyllocnistis* was placed in *Tineina*, which included many different genera of small moths (Clemens 1863; Zeller 1873, 1877; Chambers 1875; Frey & Boll 1876; van Deventer 1904). Stainton (1863) summarized the generic characters of twenty genera of leaf-mining Lepidoptera. He placed *Phyllocnistis* in a group with *Bucculatrix* Zeller, 1839, *Cemiosoma* Zeller, 1848, *Lithocolletis* Hübner, 1825, *Lyonetia* Hübner, 1825, and *Nepticula* Heyden, 1843. All these genera, except *Bucculatrix*, have a mining larva and *Lithocolletis* and *Phyllocnistis* pupate within the mine (Stainton 1863). Chambers (1871) noted that the larva of *Phyllocnistis* resembles the young cylindrical larva of *Lithocolletis* in general appearance and compared adult *Phyllocnistis* with the white species of *Lithocolletis*. In his work on Australian Microlepidoptera, Meyrick (1880: 136) made an attempt to classify the species he was describing and placed *Phyllocnistis* into *Lyonetidae* [sic], and stated “[*Phyllocnistis*] appears by its quite smooth head and apodal larva to be an extreme development of [*Opostega* and *Cemiosoma*]”. Heinemann & Wocke (1877) separated *Phyllocnistidae* as a separate family and included three genera within: *Phyllocnistis*, *Cemiosoma*, and *Bucculatrix*.

Even at the turn of the century, the definition and placement of *Phyllocnistis* differed among microlepidopterists. Noting similarities in early stages and habits of the American species, Busck (1900) proposed to broaden the definition of *Phyllocnistis*. He described *P. intermediella* Busck, 1900 from Florida, which has morphological features that are somewhat different from the species that had previously been described in the genus. Rebel (1901) allocated *Phyllocnistis* to the subfamily *Phyllocnistinae* along with *Bucculatrix* Zeller, 1839, *Cemiosoma* Zeller, 1848, *Opogona* Zeller, 1853, and *Opostega* Zeller, 1839, but placed *Phyllocnistinae* into family *Lyonetiidae*. Kirby (1903) divided *Lyonetiidae* into two subfamilies: *Lyonetiinae* and *Phyllocnistinae* [sic]. Meyrick (1895) transferred *Phyllocnistis* to *Tineidae* and in 1906 he placed it along with *Epicnistis* Meyrick, 1906, *Exorectis* Meyrick, 1906, *Leucoptera* Hübner, 1825, *Nepticula* Heyden, 1843, and *Setomorpha* Zeller, 1852. Spuler (1910) recognized three species of *Phyllocnistis*, *P. suffusella* Zeller, 1847, *P. sorhageniella* Lüders, 1900, and *P. saligna* (Zeller, 1839) and placed the genus in its own family *Phyllocnistidae*. Meyrick (1915a, b) continued to include *Phyllocnistis* in *Lyonetiidae*, which he spelled in different ways (Meyrick 1915a, b, 1916, 1920, 1921a). Other authors also included *Phyllocnistis* in *Lyonetiidae* (e.g. Turner 1923; Braun 1925). Braun and Meyrick independently¹ transferred *Phyllocnistis* from *Lyonetiidae* to *Gracillariidae* (Braun 1927; Meyrick 1928a, b, 1935, 1936), and such a placement has since been widely accepted (Turner 1947; Nye & Fletcher 1991; Davis & Robinson 1998). However,

some authors have treated *Phyllocnistis* as a separate family until recently (Seksyaeva 1981; Emmet 1985; Kuznetsov & Stekolnikov 1987; Powell & Opler 2009).

Placement of *Phyllocnistis* within Phyllocnistinae

Most modern authors divide Gracillariidae into three subfamilies: Gracillariinae, Lithocolletinae and Phyllocnistinae (Davis 1983; Davis & Miller 1984; Common 1990; Davis & Robinson 1998; Kuznetsov & Baryshnikova 1998; Parenti 2000; Dall'Asta *et al.* 2001; Heppner 2004; De Prins & De Prins 2005). However, some other authors have proposed to erect additional subfamilies: Oecophyllembiinae (Réal & Balachowsky 1966; Kumata 1998), Ornichinae (Kuznetsov & Stekolnikov 1987; misspelled as 'Orniginae' (Kuznetsov & Baryshnikova 2001; Kuznetsov & Stekolnikov 2001), and Orni-xolinae (Kuznetsov & Baryshnikova 2001). In the checklist of the Moths of America North of Mexico, Davis (1983) included *Phyllocnistis* Zeller, 1848 and *Metriochroa* Busck, 1900 in Phyllocnistinae, while Kuznetsov (1981) considered *Metriochroa* Busck, 1900 belonging to Gracillariinae. Later Davis and Robinson (1998) included *Cryphiomystis* Meyrick, 1922, *Metriochroa* Busck, 1900, *Phyllocnistis* Zeller, 1848 and *Prophyllonistis* Davis, 1994 in Phyllocnistinae. Kumata (1998) then transferred all but *Phyllocnistis* to Oecophyllembiinae based on hindwing venation and position of the larval thoracic spiracles. In the classification and checklist of the Lepidoptera species recorded in southern Africa, Vári *et al.* (2002) treated Oecophyllembiinae as a synonym of Phyllocnistinae and included *Cryphiomystis* Meyrick, 1922, *Metriochroa* Busck, 1900 and *Phyllocnistis* Zeller, 1848 into Phyllocnistinae. De Prins & De Prins (2005, 2009) recognized seven genera in Phyllocnistinae: *Angelabella* Vargas & Parra, 2005, *Corythoestis* Meyrick, 1921b, *Eumetriochroa* Kumata, 1998, *Guttigera* Diakonoff, 1955, *Metriochroa* Busck, 1900, *Phyllocnistis* Zeller, 1848, and *Prophyllonistis* Davis, 1994. It still remains largely uncertain whether these groups are monophyletic, and we hope that future phylogenetic studies based on morphological and molecular characters of Gracillariidae will shed light on the phylogenetic position of *Phyllocnistis*, and its placement in the classification of Gracillariidae.

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¹ Although the publication of Braun (1927) preceded the publication of Meyrick (1928a), we consider that both authors came to the conclusion to include *Phyllocnistis* into Gracillariidae independently and at the same time. Braun (1927) published the description of *Phyllocnistis finitima* Braun, 1927, which she placed into Gracillariidae. Meyrick (1928a) significantly revised his monumental monograph of 914 pages, which includes the identification keys of genera, species, illustrations of wing venation and short species descriptions. He recognised six genera within Gracillariidae: *Acrocercops* Wallengren, 1881, *Gracilaria* [sic] Haworth, 1828, *Lithocolletis* Hübner, 1825, *Ornix* Treitschke, 1833, *Paractopa* Clemens, 1860, and *Phyllocnistis* Zeller, 1848. The preface of his revised handbook was written on 28th September 1927, the same year as the paper of Braun (1927) was published. We believe both lepidopterists communicated with each other on the placement of *Phyllocnistis*.

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